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Acrylamide concentrations in grilled foodstuffs of Turkish kitchen by high performance liquid chromatography-mass spectrometry

Olcay Kaplan [a], Gokce Kaya [b], Cemile Ozcan [d], Muharrem Ince [c], Mehmet Yaman [d,*]

[a] Tunceli University, Engineering Faculty, Department of Food Sciences, Tunceli, Turkey
[b] Adiyaman University, Sciences and arts Faculty, Department of Chemistry, Adiyaman, Turkey
[c] Mus Alpaslan University, Education Faculty, Department of Science, Mus, Turkey
[d] Firat University, Sciences and arts Faculty, Department of Chemistry, Elazig, Turkey

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ABSTRACT

For over ten years, there has been a considerable interest in determination of acrylamide in foodstuffs. It was known that both protein-rich and carbohydrates-rich foods cooked at high-temperatures can cause acrylamide formation. However, carbohydrates-rich foods such as potato chips and biscuit samples have been the common studied foods compared with protein-rich foods such as meat samples.
In this study, determination of acrylamide in these two group foods was examined using HPLC-MS. For this purpose, firstly, the parameters that are thought to affect the response in the HPLC-MS analysis were optimized. The optimized conditions were found to be 0.3 ml min^{-1} for flow rate of mobile phase, 40 µl for injection volume, 5 °C for column temperature and 70 V for fragmentor potential. The optimized method was applied for the determination of acrylamide levels in Turkish foodstuffs including grilled meat and chicken samples, potato chips, coffee and biscuit. The obtained concentrations for all studied foods were in the range of 20–250 µg kg^{-1}. The results showed that acrylamide concentrations highly varied depending on the kind of food samples.

1. Introduction

There has been a considerable interest in determination of acrylamide in the foodstuffs because Swedish National Food Administration reported the high alarmingly concentrations of acrylamide in heat-treated potatoes and similar baked foods in 2002 [1]. It was reported that acrylamide occurs above 120 °C during the browning process named with Maillard reaction which involves the reaction of a specific amino acid with a reducing sugar [2–4]. Particularly, acrylamide forms as a result of the reaction between asparagine and glucose in preparing of carbohydrates-rich foods using frying, baking or grilling [1–5]. Furthermore, the acrylamide formation depends on cooking time, cooking source and the shape of the cooked food as well as cooking temperature. For determination of acrylamide, the common studied food samples are potato chips, coffee, fried or cooked meat products, cookies, cereals, hamburger, bread etc. [6–11]. Briefly, WHO (World Health Organization) and FAO (Food and Agriculture Organization) reported that certain foods processed or cooked at high temperature can contain considerable acrylamide and may cause risks for human health [12]. As a result, The International Agency for Research on Cancer and the European Union have classified acrylamide as carcinogen [13]. Due to the existence of many different results [1–11,14–19] on acrylamide levels in foods, there is a necessity for more studies related with acrylamide concentrations in foodstuffs processed at high temperature.

For the determination of acrylamide concentration in food samples, analytical methods such as GC-MS [4,9,14,15] and HPLC-MS [5,8,10,11,16,17] have been generally used. In HPLC-MS method, two ionization modes, atmospheric pressure chemical ionization (APCI) and electrospray (ES), are in demand. However, it was reported that APCI resulted in lower sensitivity [8]. Murkovic et al. found mean acrylamide values of 152 ng g^{-1} for potato chips, 204 ng g^{-1} for coffee, 275 ng g^{-1} for cookies by HPLC method [7]. In another study, Dunovskà et al. applied different frying time and oil temperature to potato chips samples, and they found 10,722 µg kg^{-1} for the sample fried for 360 s [15]. Rydberg et al. [16] investigated the effect of pH and heating temperature on the formation of acrylamide by using LC-MS/MS. The extraction of acrylamide from the samples is a subject to be taking into consideration as well as the optimization of parameters in LC-MS. The most commonly used solvent for extraction is water because acrylamide is high polar molecule. As a result, acrylamide is highly soluble in water and less soluble in organic solvents. In preparing the sample, fat is removed by using n-hexane for improving the swelling properties [19]. In one study, methanol/water mixture at different percentages was used as extraction reagent, and the extracts were analyzed by using LC-MS/MS [11]. Tareke et al. measured acrylamide concentrations in carbohydrates-rich foods such as potato, beetroot, potato products and crispbread [18]. They determined acrylamide levels in the range of

* Corresponding author. Tel.: +90 424 2370000/3684; fax: +90 424 2330062.
E-mail address: myaman@firat.edu.tr (M. Yaman).

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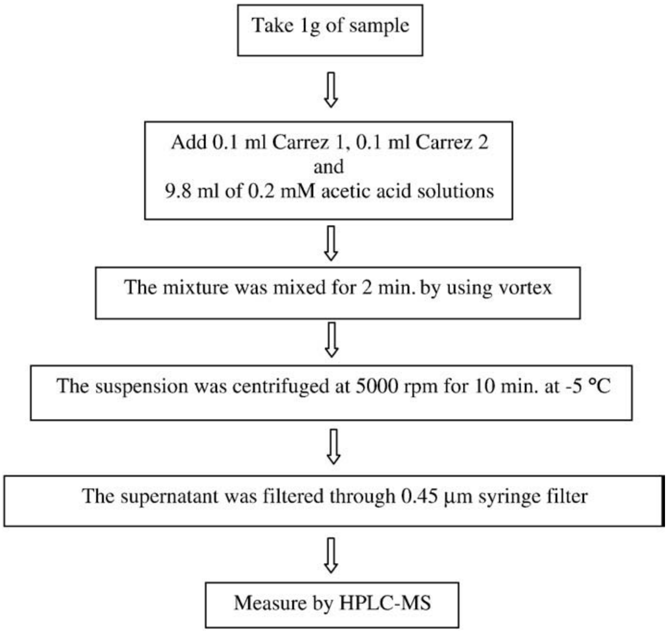

Fig. 1. Sample preparation steps for extraction of acrylamide.

150–4000 µg kg^{-1} in those samples by using GC-MS and LC-MS/MS [18]. Elmore et al. [20] studied acrylamide determination in various cake samples cooked at 180 °C for different cooking times changed from 5 to 60 min. They found that acrylamide concentration increased depending on increasing the asparagine, water and total reducing sugar content in sample [20]. Senyuva et al. [10] determined acrylamide concentration in different Turkish food samples such as crackers, potato chips, biscuits, cakes and baby foods. They found that acrylamide concentrations of crackers were the highest and the chocolates acrylamide concentrations were the lowest [10]. Although maximum limits for acrylamide in foods have not been established, it was reported that an average daily intake of approximately 100 µg of acrylamide could correspond to a non-negligible cancer risk to the general population [18]. Although protein-rich foods such as meat samples cooked at high-temperatures can also cause to acrylamide formation, carbohydrates-rich foods have been generally studied for determination of acrylamide [10,18,21,22]. It is understood that acrylamide concentrations in food samples change depending on the consumption habits because of differences in the preparation of foods and nutrition varieties of countries. As a result, some authors investigated the acrylamide concentrations in foodstuffs consumed in their countries to determine risk assessment [23–27]. In Turkey, there is common consumption in grilled meat on charcoal fire. This study was focused on Turkish grilled meat (Adana kebab, kusbasi,

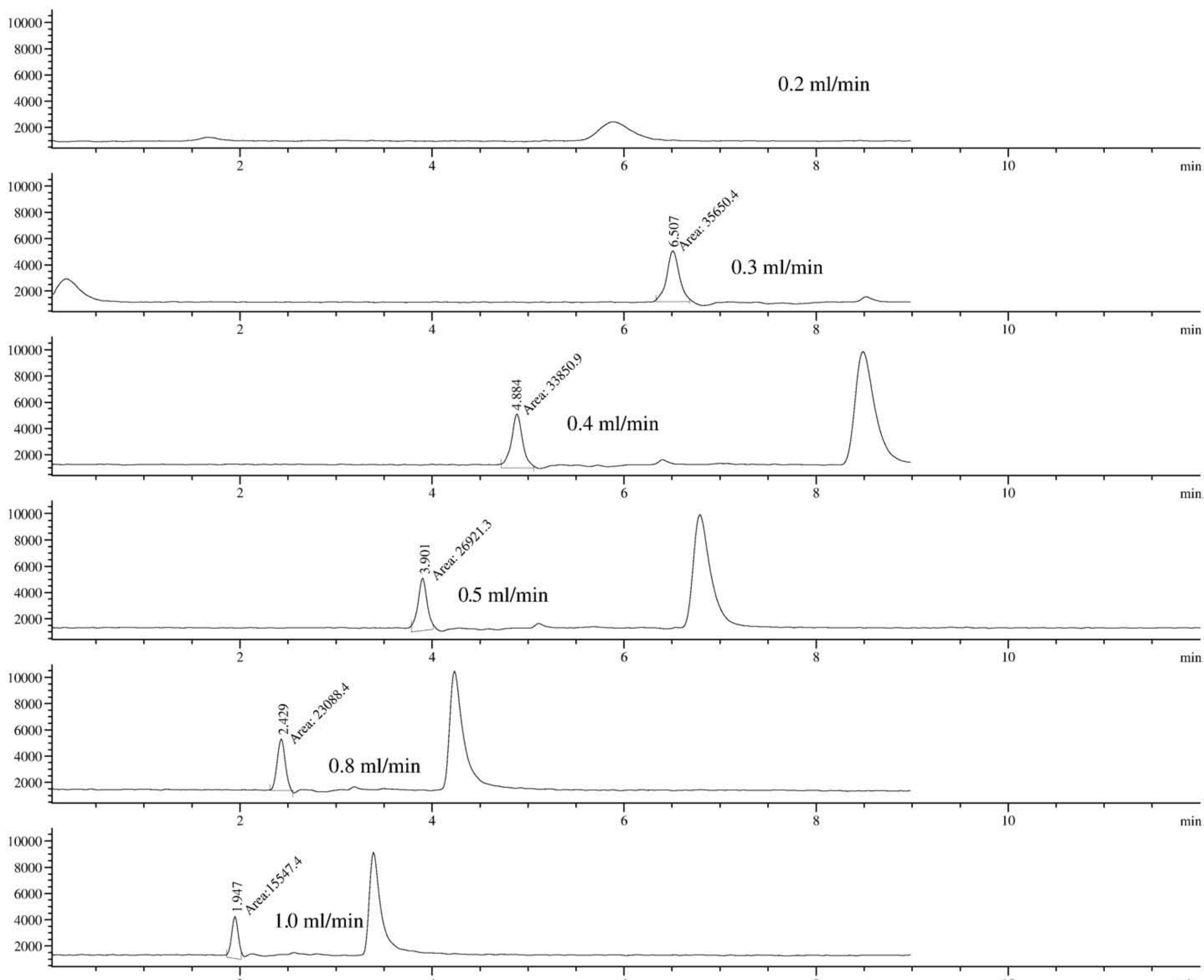

Fig. 2. HPLC-MS Chomatograms of acrylamide solutions for determination of optimum flow rate.